PHYSICAL CHEMISTRY

TARGET CSIR NET | IIT GATE

ELECTRO-CHEMISTRY

DPP :- 1-8

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QUANTA POINT

DPP- (1) Electrochemistry

Multiple Choice Questions (MCQs)

1. $E^0_{Cl^-/AgCl/Ag} = 0.22\ V$ $E^0_{Ag^+/Ag} = 0.80\ V$

Find E° for the given reaction

$Ag^+(aq) + Cl^-(aq) \longrightarrow AgCl(s)$

(a) 1.02 V (b) 0.58 V (c) – 0.58 V (d) – 1.02 V

2. Correct cell representation for the given cell reaction is

$H_2 + Cd^{2+} \longrightarrow Cd + 2H^+$

(a) H_2 (aq) | H^+ (aq) || Cd^{2+} (aq) | Cd(s) (b) Cd(s) | Cd^{2+} (aq) || H^+ (aq) | H_2 (g)

(c) Pt | H_2(g) | H^+ (aq) || Cd^{2+} (aq) | Cd(s) (d) Pt | H_2(g) | H^+ (aq) || $Cd_{(s)}$ | Cd^{2+} (aq)

3. Which of the following formulae is incorrect regarding cell potential?

(a) $E_{cell} = E_{red}$ (cathode) – E_{red} (anode) (b) $E_{cell} = E_{red}$ (cathode) + E_{red} (anode)

(c) $E_{cell} = E_{oxi}$ (anode) – E_{oxi} (cathode) (d) $E_{cell} = E_{oxi}$ (anode) + E_{red} (cathode)

4. Which of the following statement are correct regarding inert electrolyte used in salt bridge?

(a) The ions of electrolyte should not react with other ions in the solution.

(b) The ions of inert electrolyte should not participate in oxidation and reduction at electrodes.

(c) The mobility of ions of electrolyte should be almost same

(d) All are correct.

5. For cell reaction $2Ce^{4+} + Co \rightarrow 2Ce^{3+} + Co^{2+}$ E^0_{cell} is 1.89 V. If $E^0_{Co^{2+}/Co}$ is – 0.28 V. What is the value of $E^0_{Ce^{4+}/Ce^{3+}}$?

(a) 1.61 V (b) – 1.61 V (c) 2.17 V (d) – 2.17 V

6. $Au\left|Au(CN)_2^-, CN^-\right|\bar{O}H\left|O_2\right|Pt$

$E^0_{\bar{O}H/O_2/Pt} = 0.401\ V$ $E^0_{Ac(CN)_2^-, CN^-/Au} = -0.601\ V$

Fnd E^0_{cell}

(a) – 1.002 (b) 1.002 (c) 0.200 (d) – 0.200

7. $Ag^+ + e^- \longrightarrow Ag$ $E^o = 0.80$

$Ni^{2+} + 2e^- \longrightarrow Ni$ $E^o = -0.25$

Find E^0_{cell} of the cell formed by combining these two electrodes

(a) + 1.05 V (b) – 1.05 V (c) 0.55 V (d) + 1.35 V

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8. $Ag + Cl^- \longrightarrow AgCl + e^-$ $E^o = -0.22$ V

$AgBr + e^- \longrightarrow Ag + Br^-$ $E^o = 0.09$ V

Find E^o of the reaction: $(AgCl + Br^- \longrightarrow AgBr + Cl^-)$

(a) – 0.13 V (b) 0.31 V (c) – 0.31 V (d) 0.13 V

9. The standard electrode potential of SHE is zero because

(a) Hydrogen is easier to oxidise (b) Electrode potential is assumed to be zero

(c) H atom has 1 e^- (d) H is lightest element

10. For a working cell

(a) $E_{cell} < 0$ (b) $E_{cell} > 0$

(c) $E_{cell} = 0$ (d) E_{cell} can have any value

11. In a galvanic cell

(a) Chemical reaction produces electrical energy

(b) Electricl energy produces chemical reaction

(c) Reduction occurs at anode

(d) Oxidation occurs at cathode

12. E^o for $F_2 + 2e^- \longrightarrow 2F^-$ is 2.8 V

E^o for $1/2\ F_2 + e^- \longrightarrow F^-$ is

(a) 2.8 V (b) 1.4 V (c) – 2.8 V (d) – 1.4 V

13. $Pt^{2+} + 2Cl^- \rightarrow Pt + Cl_2$ $E_{cell}^0 = -0.15$ V

$P^0_{Pt^{2+}/Pt} = 1.20$ V $E^0_{Cl_2/Cl^-} = ?$

(a) – 1.35 V (b) + 1.35 V (c) – 1.05 V (d) + 1.05 V

14. Consider following E^o values

$E^0_{Fe^{3+}/Fe^{2+}} = +0.77$ V $E^0_{Sn^{2+}/Sn} = -0.14$ V

Under standard conditions, potential for the reaction

$Sn(s) + 2Fe^{3+}(aq) \rightarrow 2Fe^{2+}(aq) + Sn^{2+}(aq)$

(a) 0.63 V (b) 1.40 V (c) 1.68 V (d) 0.91 V

15. $E^0_{Zn/Zn^{2+}} = 0.76$ V $E^0_{Cu/Cu^{2+}} = -0.34$ V

Find E^0_{cell} for $Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$

(a) – 1.10 V (b) 0.42 V (c) 1.10 V (d) – 0.42 V

Multiple Select Questions (MSQs)

16. Which of the following statement is/are correct regarding salt bridge?

(a) It minimizes liquid junction potential of two liquids

(b) It maintains electrical neutrality of the solution in order to give continuous flow of current

(c) It prevents mechanical mixing of two electrolytic solutions

(d) It allows mixing of two electrolytic solution.

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17. Which of the following statement are correct regarding daniel cell?

(a) $E_{cell}^{0} = 1.10$ V

(b) Cathode is positively charged and anode is negatively charged

(c) Anode is positively charged and cathode is negatively charged.

(d) An electrical double layer is formed around the rod, which develops a potential difference between the rod and solution which is K, as electrode potential.

18. Which of the following statement is correct regarding cell representation?

(a) salt bridge is represented by double dashed line

(b) Two different phases are seperated by a single vertical line

(c) A single dashed vertical bar indicates junction between two miscible liquid phases

(d) Insoluble substances are not represented

Numerical Answer Type (NAT)

19. Calculate the EMF of a daniel cell when the concentration of $ZnSO_4$ and $CuSO_4$ are 0.001 M and 0.1 M respectively. The standard EMF of the cell is 1.1 V

20. Find E_{cell}^{0} for

$Cd^{2+} + 4NH_3 \longrightarrow [Cd(NH_3)_4]^{2+}$

$E^{0}_{Cd(NH_3)_4^{2+}/NH_3/Cd} = -0.61\,V$

$E^{0}_{Cd/Cd} = 0.40$ V

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DPP- (2) Electrochemistry

Multiple Choice Questions (MCQs)

1. Std. reduction potential of three metals A,B and C are 0.5 V, – 3.0 V, – 1.2 V. The reducing power of metals are
   (a) A > B > C (b) C > B > A (c) A > C > B (d) B > C > A

Common data (for Q. 2 and Q. 3)

Data: Reduction potential values are given below:

$Al^{3+}/Al = -1.67$ volt $Mg^{2+}/Mg = -2.34$ V

$Cu^{2+}/Cu = +0.34$ V $I_2/I^- = +0.53$ V

2. Which one is the best reducing agent?
   (a) Al (b) Mg (c) Cu (d) I^-
3. Which one is the best oxidising agent?
   (a) Al^{3+} (b) Mg^{2+} (c) Cu^{2+} (d) I_2
4. If reduction potential of A is more than B, then
   (a) A is better oxidising agent than B (b) B is better reducing agent than A
   (c) A is better reducing agent than B (d) B is better oxidising agent than A
   (a) A and B (b) A and C (c) B and D (d) C and D
5. Standard electrode potentials are
   Fe^{2+}/Fe, $E^0 = -0.44$ V
   Fe^{3+}/Fe^{2+}, $E^0 = +0.77$ V
   Fe^{2+}, Fe^{3+} and Fe blocks are kept together, then
   (a) Fe^{3+} increases (b) Fe^{3+} decreases
   (c) Fe^{2+}/Fe^{2+} remains unchanged (d) Fe^{2+} decreases
6. Can chlorine gas be stored tin Cu cylinder?
   Given : $E^0_{Cu^{2+}|Cu} = 0.34$ V $E^0_{Cl^-|Cl_2|Pt} = 1.36$ V
   (a) Yes, because, $E^0_{cell} = +ve$ (b) Yes, because, $E^0_{cell} = 0$
   (c) No, because, $E^0_{cell} = -ve$ (d) No, because, $E^0_{cell} = +ve$
7. Which of the following trend of reactivity of non metals is correct?
   (a) $F_2 > Cl_2 > Br_2 > I_2$ (b) $Cl_2 > F_2 > Br_2 > I_2$
   (c) $Cl_2 > Br_2 > F_2 > I_2$ (d) $I_2 > Br_2 > Cl_2 > F_2$

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8. The $E^0_{M^{3+}/M^{2+}}$ values for Cr, Mn, Fe and Co are – 0.41, + 1.57, + 0.77 and + 1.97 respectively. For which one of these metals, change in O.S. from +2 to +3 is easiest?
(a) Fe (b) Mn (c) Cr (d) Co

9. Which of the given metals can liberate H_2 from H_2SO_4 solution
(a) Al, Zn (b) Al only (c) Al, Zn, Cu (d) None

10. $M + nH^+ \longrightarrow n/2\ H_2 + M^{n+}$
This reaction is spontaneous for
(a) All given metals (b) Cu, Ag and Au
(c) Al and Zn (d) Al, Zn and Cu

11. Which of the given is best reducing agent?
(a) Zn (b) Al^{3+} (c) Al (d) Cr^{3+}

12. Arrange Al, Fe, Mg in the order in which they displace each other from the solution of their salts?
(a) Mg > Al > Fe (b) Al > Mg > Fe (c) Fe > Al > Mg (d) Fe > Mg > Al

13. Given

$E^0_{CeI_2/Cl^-} = 1.36\ V, E^0_{Cr^{3+}/Cr} = -0.74\ V$

$E^0_{Cr_2O_7^{2-}/Cr^{3+}} = 1.33\ V, E^0_{MnO_4^-/Mn^{2+}} = 1.51\ V$

Among the following, the strongest reducing agent is
(a) Cr^{3+} (b) Cl^- (c) Cr (d) Mn^{2+}

14. For a reaction to be spontaneous E_{cell} should not be
(a) – 2V (b) 2 V (c) 2 V (d) 4 V

15. A metal can displace H^+ from acidic solution resulting into liberation of H_2 gas
(a) If it has higher oxidation potential than H_2
(b) It has lower oxidation potential than H_2
(c) It should have positive reduction potential
(d) It should have negative oxidation potential

Multiple Select Questions (MSQs)

16. Which of the given cells are working cells?
(a) $Zn + Cu^{2+} \longrightarrow Zn^{2+} + Cu$ (b) $Zn^{2+} + Cu \longrightarrow Zn + Cu^{2+}$
(c) $2Ag^+ + Cu \longrightarrow 2Ag + Cu^{2+}$ (d) $Cu^{2+} + 2Ag \longrightarrow 2Ag^+ + Cu$

17. Which of the following metals can displace Cu^{2+} from $CuSO_4$?
(a) Zn (b) Al (c) Ag (d) Fe

18. Given data

1. $Au(CN)_2^- + e^- \longrightarrow Au + 2CN^-$	$E^o = -0.601$
2. $Fe^{3+} + e^- \longrightarrow Fe^{2+}$	$E^o = 0.771$ V
3. $Fe^{2+} + 2e^- \longrightarrow Fe$	$E^o = -0.440$ V
4. $H_2O \longrightarrow 2H^+ + 1/2\ O_2 + 2e^-$	$E^o = -1.223$
5. $O_2 + H_2O + 4e^- \longrightarrow 4\ ^-OH$	$E^o = 0.401$ V

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6. $MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 2H_2O \quad E^o = 1.51\ V$

Which of the following statement are correct?

(a) Fe reduce Fe^{3+} to Fe^{2+}

(b) Permanganate ion liberate O_2 from H_2O in the presence of acid

(c) O_2 oxidise gold to $Au(CN)_2^-$ in the presence of CN^- and ^-OH ions.

(d) We can use Zinc spon to stir $CuSO_4$ solution

Numerical Answer Type (NAT)

19. How many reactions are feasible

(a) $Fe + Zn^{2+} \longrightarrow Fe^{2+} + Zn$

(b) $Zn + 2Ag^+ \longrightarrow Zn^{2+} + 2Ag$

(c) $Cu + 2AgNO_3 \longrightarrow Cu(NO_3)_2 + 2Ag$

Given: $E^0_{Fe/Fe^{2+}} = 0.44\ V \quad E^0_{Zn^{2+}/Zn} = -0.76\ V$

$E^0_{Ag^+/Ag} = 0.80\ V \quad E^0_{Cu^{2+}/Cu} = 0.34\ V$

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DPP- (3) Electrochemistry

Multiple Choice Questions (MCQs)

1. Calculate E° for $2Cu^+ \rightarrow Cu + Cu^{2+}$

   Given $E^\circ_{Cu^+|Cu} = 0.52V$, $E^\circ_{Cu^{2+}|Cu^+} = 0.16V$

   (a) 0.36V (b) 0.68V (c) 0.84V (d) 1.20V

2. $E^\circ_{Fe^{3+}/Fe} = -0.036$ V, $E^\circ_{Fe^{+2}/Fe} = -0.439$ V

   Value of standard electrode fotential for the change

   $Fe^{3+} + e^- \rightarrow Fe^{2+}$ will be

   (a) 0.772V (b) –0.27V (c) –0.072V (d) 0.385V

3. If ΔG° of the cell reaction,

   $AgCl(s) + \frac{1}{2}H_2(g) \rightarrow Ag(s) + H^+ + Cl^-$ is –21.52 kJ then ΔG° of

   $2AgCl(s) + H_2(g) \rightarrow 2Ag + 2H^+ + 2Cl^-$

   (a) –21.52 kJ (b) –10.76 kJ (c) –43.04 kJ (d) 43.04 kJ

4. Which of the following properties are extensive?

   (a) ΔG° (b) E_{cell} (c) E°_{cell} (d) $E^\circ_{cathode}$

5. Which of the following properties are intensive?

   (a) E_{cell} (b) ΔG (c) ΔG° (d) None of the above

6. For a spontaneous reaction.

   (1) $\Delta G < 0$ (2) $\Delta G > 0$ (3) $E_{cell} < 0$ (4) $E_{cell} > 0$

   (a) Only (1) is correct (b) (1) and (3) are correct

   (c) (1) and (4) are correct (d) Only (4) is correct

7. Find ΔG° for the given cell

   $Zn(s) + Cu^{2+} \rightarrow Zn^{2+} + Cu(s)$

   $E^\circ_{Zn^{2+}/Zn} = -0.76v$, $E^\circ_{Cu^{2+}/Cu} = 0.34v$

   (a) 212.3 J mol^{-1} (b) –212.3 kJ mol^{-1} (c) 313 kJ mol^{-1} (d) –313 kJ mol^{-1}

8. Find E° and ΔG° for the given cell

   $Pt|CO_2|$oxalic acid, $H^+ \vdots\vdots MnO_4^-, Mn^{2+}, H^+/Pt$

   $E^\circ_{MnO_4^-, Mn^{2+}, H^+/Pt} = 1.51V$ $E^\circ_{Oxalic\ acid, H^+/CO_2/Pt} = -0.49$ v

   (a) 2V, 1.93×10^6 J mol^{-1} (b) 2V, 19.3 kJ mol^{-1}

QUANTA POINT

(c) 2V, 19.3 J mol^{-1} (d) 2V, -1.93×10^6 J mol^{-1}

9. $Cd^{2+} + 2e^- \rightarrow Cd(s)$ $E^o = -0.40V$

$Ag^+ + e^- \rightarrow Ag(s)$ $E^o = 0.80V$

Find ΔG^o for $2Ag^+ + Cd(s) \rightarrow 2Ag(s) + Cd^{2+}$ (ΔG)

(a) 115.8 kJ mol^{-1} (b) –115.8 kJ mol^{-1} (c) –231.6 kJ mol^{-1} (d) +231.6 kJ mol^{-1}

10. For a spontaneous reaction ΔG, K_{eq} and E_{cell} will be respectively

(a) –ve, < 1, + ve (b) –ve, > 1, –ve (c) –ve, > 1, +ve (d) +ve, > 1, –ve

11. $Cu^{2+}(aq) + e^- \rightarrow Cu^+(aq)$, $E_1 = 0.153V$

$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$, $E_2 = 0.337V$

Calculate E for $Cu^+(aq) + e^- \rightarrow Cu(s)$

(a) 0.521V (b) 0.487V (c) 0.260V (d) 0.827V

12. $Zn \mid Zn^{2+}(C_1) \mid\mid Cu^{2+}(C_2) \mid Cu$

$E_{cell} - E^0_{cell} = 0.0591$ V . The ratio of $\frac{C_1}{C_2}$ at 298 K is

(a) 2.0 (b) 10.0 (c) 10^{-2} (d) 1.0

13. Given electrode potential:

$Fe^{3+} + e^- \longrightarrow Fe^{2+}$ $E^0 = 0.771$ Volts

$I_2 + 2e^- \longrightarrow 2I^-$ $E^0 = 0.536$ Volts

E^0_{cell} for the cell reaction

$2Fe^{3+} + 2I^- \longrightarrow 2Fe^{2+} + I_2$ is

(a) $(2 \times 0.771 - 0.563) = 1.006$ V (b) $(0.771 - 0.5 \times 0.536) = 0.5.3$ V

(c) $0.771 - 0.530 = 0.235$ V (d) $0.536 - 0.771 = -0.235$ V

14. Find ΔG^o for the given reaction

$Zn + 2Ag^+ \rightarrow 2Ag + Zn^{2+}$

$E^\circ_{Ag^+/Ag} = 0.80$ V, $E^\circ_{Zn^{2+}/Zn} = -0.76$ V

(a) 301 kJ mol^{-1} (b) –301 kJ mol^{-1} (c) –301 J mol^{-1} (d) –150 kJ mol^{-1}

15. Find ΔG^o for the given cell

$Au|Au(CN)_2^-, CN^- \vdots\vdots \bar{O}H|O_2|Pt$

$E^0_{OH^-|O_2|Pt} = 0.401$ $E^\circ_{Au(CN)_2^-, CN^-/Au} = -0.601V$

(a) –412 kJ mol^{-1} (b) –205 kJ mol^{-1} (c) –194 kJ mol^{-1} (d) –386 kJ mol^{-1}

Multiple Select Questions (MSQs)

16. Which of the following statements is/are correct?

(a) ΔG^o is extensive property

(b) E_{cell} is intensive property

(c) E^o of an electrode gets changed if the electrode reaction is multiplied by a number

(d) ΔG^o change on changing stoicheometry of the reaction

QUANTA POINT

17. For the reaction $C_4H_{10} + \frac{13}{2}O_2 \rightarrow 4CO_2 + 5H_2O$. It change in Gibbs free energy is –2740.06 kJ mol^{-1}. Then which of the following statements regarding this reaction is correct

(a) It involves 26 e^- (b) Its $E_{cell} = -1.09V$

(c) $E_{cell} = +1.09V$ (d) Reaction is spontaneous

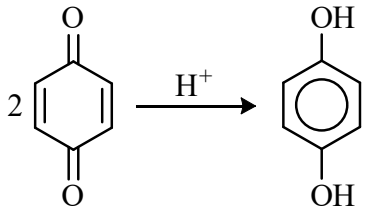
18. Which of the following relation is correct?

(a) $\Delta G = -nF\ E_{cell}$ (b) $\Delta G^o = -nF\ E_{cell}$ (c) $\Delta G^o = -nFE^\circ_{cell}$ (d) $\Delta G = -nFE^\circ_{cell}$

Numerical Answer Type (NAT)

19. The standard electrode potential of Fe^{3+}/Fe^{2+} and Fe^{2+}/Fe are 0.77V and –0.44V at 298K. What is magnitude of E^o for Fe^{3+}/Fe.

20. Find no of e^- involved in the following reaction



QUANTA POINT

DPP- (4) Electrochemistry

Multiple Choice Questions (MCQs)

1. $Ag \mid 0.1\ M\ AgNO_3 \parallel KCl \mid AgCl \mid Ag$
   $0.1\ M$
   Given KCl dissociates 85% and 0.1 M $AgNO_3$ dissociates 82%. Find E_{cell}.
   Given $E^0_{Ag^+/Ag} = 0.80\ V$ and $E^0_{Cl/AgCl/Ag} = 0.222\ V$
   (a) + 0.45 V (b) 0.60 V (c) – 0.45 V (d) 0.82 V

2. $BrO_3^- \xrightarrow{E^o = 0.54} BrO^- \xrightarrow{E^o = 0.45} \frac{1}{2}Br_2 \xrightarrow{E^o = 1.07} Br^-$
   $E^o = 0.76$
   Find $E^{\circ}_{BrO_3^-/Br_2}$
   (a) 0.60 V (b) 0.32 V (c) 0.16 V (d) 0.52 V

3. Determine the standard equilibrium constant of the following reaction at 298 K
   $2Fe^{3+} + Sn^{2+} \longrightarrow 2Fe^{2+} + Sn^{4+}$
   (a) 10^{15} (b) 10^{21} (c) 10^{48} (d) 10^{32}

4. $Al(s) \mid Al^{3+}(0.01\ M) \parallel Fe^{2+}(0.1M) \mid Fe(s)$
   Find E_{cell}. Given $E^0_{Al^{3+}/Al} = -1.66\ V$ and $E^0_{Fe^{2+}/Fe} = -0.44\ V$
   (a) 0.23 V (b) 1.23 V (c) 1.48 V (d) 0.48 V

5. For a cell constructed with $Cu(s) \mid Cu^{2+}(aq)$ anode and $Ag^+(aq) \mid Ag(s)$ cathode at 25ºC. Calculate cell potential at 25 ºC under non standard conditions.
   $[Cu^{2+}] = 0.3\ M$ and $[Ag^+] = 0.05\ M$
   (a) 0.398 V (b) – 0.398 V (c) 0.46 V (d) 1.46 V
   Given $Ag^+ + e^- \longrightarrow Ag \quad E^0 = 0.80\ V$
   $Cu \longrightarrow Cu^{2+} + 2e^- \quad E^0 = 0.34\ V$

6. E^0 values are given for a reaction sequence
   $Mn^{+6} \xrightarrow{1.28\ V} Mn^{+5} \xrightarrow{2.9\ V} Mn^{+4} \xrightarrow{0.96\ V} Mn^{3+} \xrightarrow{1.5\ V} Mn^{+2}$
   Find E^0 for $Mn^{+6} + 4e^- \longrightarrow Mn^{2+}$.
   (a) 2.66 V (b) 0.66 V (c) 1.66 V (d) 1.33 V

7. Calculate electrode potential of the given half cell.
   $H^+ / O_2 / Pt \quad E^0 = 1.27, Ph = 7, Po_2 = 1$
   (a) 1.856 (b) 0.456 (c) 0.856 (d) 1.27

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8. $Cd \mid CdCl_2 \mid AgCl \mid Ag$
(0.01 M)
$E_{cell} = 1.969$ V
Find $E^0_{cell} = ?$
(a) 1.81 V (b) 0.81 V (c) 0.969 V (d) 1.7917 V

9. $Cd \mid CdI_2$ (a) $\mid AgI$ (s) $\mid Ag$
The potential of cell is 0.2860 V at 25 ºC. Calculate mean ionic activity of ions in solution.
(a) 0.40 (b) 0.064 (c) 0.82 (d) 0.94

10. A hydrogen electrode is dipped in a solution of pH = 3 at 25 ºC. The potential of the cell will be
(a) 0.177 V (b) 0.087 (d) – 0.177 (d) 0.059 V

11. A cell contains two hydrogen electordes. The negative electrode is in contact with a solution of 10^{-6} M H^+ ions. The emf of cell is 0.118 at 25º C. Calcualte the concentration of hydrogen at the positive electrode.
(a) 10^{-1} (b) 10^{-7} (c) 10^{-4} (d) 10^{-6}

12. The emf of the cell
$Zn \mid Zn^{2+}$ (0.01 M) $\| Fe^{2+}$ (0.001 M) $\mid Fe$
at 298 K is 0.2905 volt. Then the value of equilibrium constant for the cell reaction is
(a) $e^{\frac{0.32}{0.0295}}$ (b) $10^{\frac{0.32}{0.0295}}$ (c) $10^{\frac{0.26}{0.0295}}$ (d) $10^{\frac{0.32}{0.0591}}$

13. In a cell that utilizes the reaction
$Zn(s) + 2H^+(aq) \longrightarrow Zn^{2+}(aq) + H_2(g)$
Addition of H_2SO_4 to the cathode compartment will
(a) Lower the E and shift equilibrium to the left
(b) Lower the E and shift equilibrium to the right
(c) Increases the E and shift equilibrium to the right
(d) Increases the E and shift equilibrium to the left

14. A zinc rod, is dipped in 0.1 M solution of $ZnSO_4$. The salt is 95% dissociated at this dilution at 298 K. Calculate the electrode potential $\left(E^0_{Zn^{2+}/Zn} = -0.761 \text{ V}\right)$
(a) – 0.79 V (b) 0.79 V (c) 0.52 V (d) – 0.52 V

15. Calculate the cell e.m.f at 25 ºC for the cell: $Mg(s) \mid Mg^{2+}$ (0.01 M) $\| Sn^{2+}$ (0.1 M) $\mid Sn$ (s)
Given: $E^0_{Mg^{2+}/Mg} = -2.34$ V, $E^0_{Sn^{2+}/Sn} = -0.136$ V, $1F = 96{,}500$ C mol^{-1}
Calculate the maximum work that can be accompalished by the operation of this cell.
(a) 3.0 (b) 2.5 (c) 2.21 (d) 1.05

Multiple Select Questions (MSQs)

16. $H^+ + e^- \longrightarrow \frac{1}{2}H_2$
R.P of this reaction
(a) ↑ with ↑ in Ph of solution (b) ↓ with ↑ in Ph of solution
(c) ↑ with ↑ in conc. of H^+ (d) ↓ with ↑ in conc. of H^+

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17. For the given half cell $H^+ / O_2 / Pt$ electrode potential

(a) $\uparrow$ with decreasing pH (b) The effect of pH is can't be predicted

(c) $\uparrow$ with increasing conc. of H^+ (d) $\downarrow$ with increasing conc. of H^+

18. Which reaction will proced to forward directionat 25 ºC (concentration and pressure are unity)

(a) $Fe + Cl_2(g) \longrightarrow Fe^{2+} + 2Cl^-$ $\left(E^0_{Fe/Fe^{2+}} = 0.44\ V\right)$

(b) $2Ag + Cu^{2+} \longrightarrow 2Ag^+ + Cu$ $\left(E^0_{Ag^+/Ag} = 0.8\ V, \quad E^0_{Cu/Cu^{2+}} = -0.34\ V\right)$

(c) $2Ag + Cu^{2+} \longrightarrow 2AgCl(s) + Cu$ $\left(E^0_{Cl^-/AgCl/Ag} = 0.22\ V\right)$

(d) $2Fe^{2+} + Cl_2\,(g) \longrightarrow 2Fe^{3+} + 2Cl^-$ $\left(E^0_{Cl_2/Cl^-} = 1.3595, \quad F^0_{Fe^{3+}/Fe^{2+}/Pt} = 0.771\right)$

Numerical Answer Type (NAT)

19. The potential of the cell

$Zn(s) \,|\, ZnCl_2\,(0.01021\ mol\ kg^{-1}) \,|\, AgCl\,(s) \,|\, Ag(s)$

is found to be 1.1566 V. What is the mean ionic activity coefficient of $ZnCl_2$ in the solution.

(Upto 2 decimal place)

20. Calculate potential at 25 ºC for the cell $Pt \,|\, H_2\,(p = 1\ bar) \,|\, HBr\,(a_{\pm} = 0.2) \,|\, Hg_2Br_2\,(s) \,|\, Hg$

(Upto 2 decimal place)

QUANTA POINT

DPP- (5) Electrochemistry

Multiple Choice Questions (MCQs)

1. The potential of the cell Ag|AgI(sat. soln.)|AgI(s)|Ag is –0.9509V at 25ºC from std. potential data calculate (a) solubility product of AgI

   (a) 8.5×10^{-17} (b) 6.5×10^{-17} (c) 4.5×10^{-15} (d) 10^{-13}

2. Find K_{eq} of dissociation of $Ag(CN)_2^-$ If $E^\circ_{Ag^+/Ag} = 0.80$ V & $E^\circ_{CN^-/Ag(CN)_2^-/Ag} = -0.31V$.

   (a) 0.6×10^{-18} (b) 16.5×10^{-19} (c) 6.04×10^{-18} (d) 1.65×10^{-19}

3. Find K_{sp} of AgCl, given $E^\circ_{Ag^+/Ag} = 0.80V$ and $E^\circ_{Cl^-/AgCl/Ag} = 0.22V$

   (a) 2.4×10^{-10} (b) 1.5×10^{-9} (c) 1.5×10^{-10} (d) 3×10^{-9}

4. Determine standard equilibrium constant of following reaction at 298K.

   $$Cu(OH)_2 \rightarrow Cu^{2+}(aq) + 2^-OH(aq)$$

   $E^\circ_{Cu^{2+}/Cu} = 0.337V$ $E^\circ_{OH/Cu(OH)_2(s)/Cu} = -0.224V$

   (a) 1.1×10^{-19} (b) 1.1×10^{19} (c) 1.1×10^{-10} (d) 1.1×10^{-15}

5. Evaluate standard equilibrium constant for formation of triodide ion

   $$I_2(aq) + I^- \rightarrow I_3^-$$

   Given $I_2(aq) + 2e^- \rightarrow 2I^-$, $E^o = 0.6197V$

   $I_3^- + 2e^- \rightarrow 3I^-$ $E^o = 0.535V$

   (a) 608 (b) 400 (c) 735 (d) 7080

6. Given that

   $Ag(CN)_2^- + e^- \rightarrow Ag + 2CN^-$; $E^\circ = -0.31$ V

   and $Ag^+ + e^- \rightarrow Ag$; $E^\circ = +0.80$ V

   Calculate the standard equilibrium constant for the reaction

   $Ag(CN)_2^- \rightleftharpoons Ag^+ + 2CN^-$

   (a) 1.68×10^{-19} (b) 1.68×10^{-18} (c) 1.68×10^{-17} (d) 1.68×10^{-16}

7. Calculate equilibrium constant for the reaction

   $$S_2O_8^{2-} + 2Fe^{2+}(aq) \rightleftharpoons 2Fe^{3+}(aq) + 2SO_4^{2-}(aq)$$

   Given $S_2O_8^{2-} + 2e^- \rightleftharpoons SO_4^{2-}$ $E^o = 2.08V$

   $Fe^{3+}(aq) + e^- \rightleftharpoons Fe^{2+}(aq)$ $E^o = 0.77V$

QUANTA POINT

(a) 10^2 (b) 2×10^{95} (c) 2×10^{44} (d) 2×10^{48}

8. Given data at 25°C

$Ag(s) + I^- \rightarrow AgI(s) + e^-$ $E^o = 0.152$ V

$Ag(s) \rightarrow Ag^+(aq) + e^-$ $E^o = -0.80$ V

Value of $\log K_{sp}$ per AgI?

(a) –8.12 (b) +8.612 (c) –37.83 (d) –16.13

9. Find equilibrium constant of $Au^{+3} + 2Au \rightarrow 3Au^+$. Given $E^o_{Au^{3+}/Au} = 1.41V$ and $E^o_{Au^{3+}/Au} = 1.50V$.

(a) 7.2×10^{-10} (b) 729×10^{-13} (c) 7.2×10^{10} (d) 729×10^{13}

10. The solubility product of silver iodide is 8.3×10^{-7} and standard reduction potential of Ag electrode is 0.8 V at 25°C. The standard reduction potential of Ag.AgI/I^- electrode from these data is –

(a) – 0.30V (b) + 0.15 V (c) + 0.10V (d) – 0.15V

11. Given the information that

$Cu^{2+} + 2e^- \rightarrow Cu$; $E° = 0.34V$

$Cu^+ + e^- \rightarrow Cu$; $E° = 0.52V$

$Cu^{2+} + Cl^- + e^- \rightarrow CuCl(s)$; $E° = 0.54V$

Calculate the standard solubility product of CuCl.

(a) 36×10^{-7} (b) 3.6×10^{-7} (c) 3.6×10^7 (d) 36×10^7

12. Calculate $\Delta G°$ for the reaction

$H_2(g) + O_2(g) \rightleftharpoons H_2O_2(l)$

at 298K. Given that :

$O_2 + 2H^+ + 2e^- \rightleftharpoons H_2O_2$; $E° = 0.682V$

(a) –132 J mole (b) –13.1626 KJ $mole^{-1}$

(c) –131.626 KJ $mole^{-1}$ (d) –1316 KJ $mole^{-1}$

13. Calculate the standard equilibrium constant for the reaction

$H_2(g) + O_2(g) \rightleftharpoons H_2O_2(l)$

at 298K. Given that :

$O_2 + 2H^+ + 2e^- = H_2O_2$; $E° = 0.682V$

(a) 1.148×10^{22} (b) 1.148×10^{-23} (c) 11.48×10^{20} (d) 1.148×10^{23}

14. $Cd^{2+} + 4NH_3 \rightleftharpoons Cd(NH_4)^{2+}$

Find stability constant of $Cd(NH_3)_4^{2+}$

Given $E^o_{Cd^{2+}/Cd} = -0.40V$ $E^o_{Cd(NH_3)_4^{2+}, NH_3/Cd} = -0.61V$

(a) 1.3×10^7 (b) 1.3×10^3 (c) 0.3×10^6 (d) 10^8

15. Given $Pd^{2+}(aq) + 2e^- \rightarrow Pd(s)$ $E^o = 0.83V$

$PdCl_4^{2-}(aq) + 2e^- \rightarrow Pd(s) + 4Cl^-(aq)$ $E^o = 0.64V$

Find log K of reaction $Pd^{2+} + 4Cl^- \rightarrow [PdCl_4]^{2-}$

(a) 4.9 (b) 2.4 (c) 6.4 (d) 1.8

QUANTA POINT

16. The cell Pt (H_2) (1 atm) | H^+(pH = ?) || I^- (a = 1) | AgI(s), Ag(s) | Pt has emf, $E_{298K} = 0$. The standard electrode potential for the reaction $AgI + e^- \rightarrow Ag + I^-$ is –0.151 V. Calcualte the pH value.

(a) 3.37 (b) 5.26 (c) 2.56 (d) 4.62

Multiple Select Questions (MSQs)

17. $Zn + 2H^+ \rightarrow Zn^{2+} + H_2$

(a) $E_{cell} \uparrow$ with $\uparrow$ in conc. of H^+

(b) E°_{cell} increases with increase in conc. of H^+

(c) E_{cell} increases with increase in PH

(d) ΔG because more negative on encreasing conc. of H^+.

18. Consider reaction, choose correct statements:

$2Fe^{3+} + Sn^{2+} \longrightarrow 2Fe^{2+} + Sn^{4+}$

$E^\circ_{Fe^{3+}/Fe^{2+}} = 0.771V$

$E^\circ_{Sn^{4+}/Sn^{2+}} = 0.150V$

(a) E°_{cell} is 0.621V (b) E°_{cell} is 0.921V

(c) Sn^{2+} can reduce Fe^{3+} quantitatively. (d) Fe^{2+} can reduce Sn^{4+} quantitatively.

Numerical Answer Type (NAT)

19. Find $\log_{10}K$ for the given reaction

$2MnO_4^- + 6H^+ + 5H_2C_2O_4 \rightleftharpoons 2Mn^{2+} + 8H_2O + 10CO_2$

$MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O \quad E^\circ = 1.51V$

$2CO_2 + 2H^+ + 2e^- \rightleftharpoons H_2C_2O_4 \quad E^\circ = -0.49V$

20. $Pt(s)|H_2|H^+aq(1H) \vdots Fe^{3+}(aq), Fe^{2+}(aq)|Pt(s)$

$E^\circ_{Fe^{3+}|Fe^{2+}} = 0.771V$, If the potential of cell is 0.712V, what is ratio of conc of Fe^{+2} of Fe^{+3}

QUANTA POINT

DPP- (6) Electrochemistry

Multiple Choice Questions (MCQs)

1. The cell Pt, H_2(1 atm) |H^+(PH=x)|| normal calomel electrode has an EMF of 0.67V at 25ºC. Calculate the pH of solution. The oxidation potential of calomel electrode on hydrogen scale is –0.28V.

   (a) 3.31 (b) 7.39 (c) 0 (d) 6.61

2. $Zn + 2H^+ \rightarrow Zn^{2+}(0.1M) + H_2(g)\,(1\,atm)$

   The EMF of cell is 0.28V at 25ºC. Calculate pH of solution at hydrogen electrode

   (a) 8.62 (b) 7 (c) 6.62 (d) 11.2

3. Consider Galvanaic cell,

   $Zn(s)\,|\,Zn^{2+}(0.1M)\,||\,Cu^{2+}(0.1M)\,|\,Cu(s)$

   by what factor, the electrolyte in anodes half cell should be diluted to increase the emf by 9 milli volt at 298K

   (a) 2 (b) 4 (c) 5 (d) 7

4. Consider the cell Ag(s)|AgBr(s)|Br^-||Cl^-|AgCl|Ag at 25ºC. The solubility product constant of AgBr and AgCl are respectively 5×10^{-13} and 10^{-10}. For what ratio of the concentration of Br^- and Cl^- ions would be EMF of the cell be zero.

   (a) 1 : 20 (b) 1 : 200 (c) 1 : 2 (d) 1 : 2000

5. Calculate EMF of cell

   $Pt(s)\,|\,H_2(1.0\,atm)\,|\,CH_3COOH(0.1M)\,||\,NH_3(aq.\,0.02M)\,|\,H_2\,|\,Pt(s)$

   $K_{a(CH_3COOH)} = 1.8\times10^{-5}$ $K_b(NH_3) = 1.8\times10^{-5}$

   (a) –0.23V (b) 0.23V (c) –0.45V (d) 0.46V

Common Data for (Q. 4 & 5)

Determine at 298 for cell

$Pt\,|\,Q, QH_2, H^+\,||\,1M\,KCl\,|\,Hg_2C_2(s)\,|\,Hg_2Cl_2(s)\,|\,Hg(\ell)\,|\,Pt$

6. It's EMF when pH = 5.0

   Given $E^\circ_{RP(RHS)} = 0.28$, $E^\circ_{RP(L.H.S)} = 0.699$

   (a) 7.1 (b) –0.124 (c) 0.124 (d) 0.248

7. The pH when $E_{cell} = 0$

   $E^\circ_{RP(R.H.S)} = 0.28$; $E^\circ_{RP(L.H.S)} = 0.699$

   (a) 0.124 (b) 7.1 (c) –7.1 (d) 6.9

8. The half cell oxidation potential at a half cell A^{x+} $A^{(x+n)+}$|Pt were found to be as follows

% reduced form	24.4	48.8
Cell potential (V)	0.101	0.115

QUANTA POINT

Determine value of n

take $\frac{2.303RT}{F} = 0.06, \log 24.4 = 1.387, \log 75.6 = 1.878, \log 48.8 = 1.688, \log 51.2 = 1.709$

(a) n = 2 (b) n = 1 (c) n = 3 (d) n = 4

9. When Iron is rusted it is

(a) reduced (b) oxidised (c) evaporated (d) decomposed

10. The half cell reactions for rusting of iron are

$2H^+ + \frac{1}{2}O_2 + 2e^- \rightarrow H_2O; E^o = +1.23$

$Fe^{2+} + 2e^- \rightarrow Fe, E^o = -0.44V$

ΔG^o for overall reaction (in KJ mol^{-1})

(a) –76 (b) –322 (c) –122 (d) –176

11. The emf of the cell, $Zn|Zn^{2+}$ (0.01M)$||Fe^{2+}$ (0.001M) 1Fe at 298K is 0.2905V. then the value of equation constant for cell reaction is

(a) $e^{\frac{0.32}{0.0295}}$ (b) $10^{\frac{0.32}{0.0295}}$ (c) $10^{\frac{0.26}{0.0295}}$ (d) $10^{\frac{0.32}{0.059}}$

12 Given the cell

$Cd \,|\, Cd(OH)_2(s) \,|\, NaOH(0.01 \text{ mol kg}^{-1}) \,|\, H_2(1\text{bar}) \,|\, Pt$

$E^{\circ}_{Cd^{2+}|Cd} = -0.40V$. Calculate (1) K_{sp} of $Cd(OH)_2$

(a) 3.36×10^{-15} M^3 (b) 3.36×10^{-10} M^3 (c) 10^{-12} M^3 (d) 6×10^{-8} M^3

13. For EMF of hydrogen electrode to be zero, what should be the pressure of H_2 required in neutral PH.

(a) 10^{-7} (b) 10^{-14} (c) 10^{-10} (d) 10^{-5}

14. The E°_{cell} for reaction $Fe + Zn^{2+} \rightleftharpoons Zn + Fe^{2+}$ is –0.32V at 25ºC. What will be the equa conc of Fe^{2+} when a piece of iron is placed in a 1M Zn^{2+} solution?

(a) 1.483×10^{-11} M (b) 5.5×10^{-10} M (c) 1.483×10^{-8} (d) 14.83×10^{-11}M

15. At what $\frac{[Br^-]}{\sqrt{CO_3^{2-}}}$ does the following cell potential is zero.

$Ag(s) \,|\, Ag_2CO_3(s) \,|\, Na_2CO_3 \,||\, KBr(aq) \,|\, AgBr(s) \,|\, Ag(s)$

$K_{sp} = 8 \times 10^{-12}$ for Ag_2CO_3 and $K_{sp} = 4 \times 10^{-3}$ for AgBr

(a) 10^{-7} (b) $\sqrt{2} \times 10^{-7}$ (c) $\sqrt{3} \times 10^{-7}$ (d) $\sqrt{4} \times 10^{-7}$

Multiple Select Questions (MSQs)

16. Using std potential values given below, decide which of the statements, I, II, III, IV are correct

$Fe^{2+} + 2e^- \rightarrow Fe \quad E^o = -0.44V$

$Cu^{2+} + 2e^- \rightarrow Cu \quad E^o = +0.34V$

$Ag^+ + e^- \rightarrow Ag \quad E^o = 0.80V$

QUANTA POINT

(a) Copper can displace iron from $FeSO_4$ solution

(b) Iron can displace copper from $CuSO_4$ solution

(c) Silver can displace Cu from $CuSO_4$

(d) Iron can displace silver from $AgNO_3$ solution

17. $E^{\circ}_{Ag^+|Ag} = 0.80V$ $E^{\circ}_{Mg^{2+}|Mg} = -2.37V$

$E^{\circ}_{Cu^{2+}|Cu} = 0.34V$ $E^{\circ}_{Hg^{2+}|Hg} = 0.79V$

Which of the following is/are correct?

(a) $AgNO_3$ can be stored in copper vessel (b) $Mg(NO_3)_2$ can be stored in Cu vessel

(c) $CuCl_2$ can be stored in silver vessel (d) $HgCl_2$ can be stored in Cu vessel

18. Choose the correct statement –

(a) $\Delta S = nF\left(\frac{\partial E}{\partial T}\right)_P$ (b) $\Delta S = nFT\left(\frac{\partial E}{\partial T}\right)_P$

(c) $\Delta H = nF\left[-E + T\left(\frac{\partial E}{\partial T}\right)_P\right]$ (d) $\Delta H = nF\left[E - T\left(\frac{\partial E}{\partial T}\right)_P\right]$

Multiple Select Questions (MSQs)

19. $2Ag^+ + C_6H_{12}O_6 + H_2O \rightarrow 2Ag(s) + C_6H_{12}O_7 + 2H^+$

Find ln K of this reaction

Hint:- $Ag^+ + e^- \rightarrow Ag$ $E^{\circ}_{red} = 0.8V$

$C_6H_{12}O_6 + H_2O \rightarrow C_6H_{12}O_7 + 2H^+ + 2e^-$ $E^{o} = -0.05V$

20. The cell $Pt \mid H_2(g)(1atm) \mid H^+; pH = x \mid$ normal calomel electrode has EMF of 0.64 volt at 25ºC. The std. reduction potential of normal calomel electrode is 0.28V. What is the pH of solution in anodic compartment.

QUANTA POINT

DPP- (7) Electrochemistry

Multiple Choice Questions (MCQs)

1. The EMF of the standard weston cadmium cell Cd (12.5%) in Hg | $3CdSO_4, 8H_2O$ (solid) | saturated solution of $CdSO_4$ || $Hg_2SO_4(s)$ | Hg is 1.0180 volts at 25°C and the temperature coefficient of the cell, $\left(\frac{\Delta E}{\Delta T}\right)_P = -4.0\times10^{-5}\,V/degree.$ Calculate ΔS for the reaction in the cell when n = 2.

   (a) $-4.7\ JK^{-1}$ (b) $-7.7\ JK^{-1}$ (c) $-2.5\ JK^{-1}$ (d) $-9.1\ JK^{-1}$

2. ΔH for the reaction $Ag(s) + \frac{1}{2}Hg_2Cl_2(s) \longrightarrow AgCl(s) + Hg(l)$ is +1280 cal at 25°C. This reaction can be conducted in a cell for which the emf = 0.0455 volt at this temperature. Calculate the temperature coefficient of the emf.

   (a) 3.3×10^{-4} volt deg^{-1} (b) 5.2×10^{-2} volt deg^{-1}
   (c) 5.2×10^{-4} volt deg^{-1} (d) 3.3×10^{-2} volt deg^{-1}

3. The standard electromotive force of the cell : Fe | Fe^{2+} (aq) || Cd^{2+} | Cd is 0.0372 V
   The temperature coefficient of e.m.f. is $-0.125\ V\,K^{-1}$. Calculate the quantities $\Delta G°$ at 25°C.

   (a) –7.1796 kJ (b) –3.52 kJ (c) –2.10 kJ (d) –71.7 kJ

4. The standard electromotive force of the cell : Fe | Fe^{2+} (aq) || Cd^{2+} | Cd is 0.0372 V
   The temperature coefficient of e.m.f. is $-0.125\ V\,K^{-1}$. Calculate the quantities $\Delta S°$ at 25°C.

   (a) $-30\ kJ\ K^{-1}$ (b) $-24\ kJ\ K^{-1}$ (c) $-17\ kJ\ K^{-1}$ (d) $-38\ kJ\ K^{-1}$

5. The voltage of a certain cell has standred potential at 25°C and 20°C are 0.3525 V and 0.3533V respectively. If the number of electrons involved in the overall reactions are two, calculate $\Delta S°$ at 25°C.

   (a) $30\ JK^{-1}$ (b) $50\ JK^{-1}$ (c) $-30\ JK^{-1}$ (d) $-50\ JK^{-1}$

6. The emf of the cell
   Ag | AgCl(s) | KCl(aq) + Hg_2Cl_2(s) | Hg
   is 0.0456 V at 298K. Calculate the free energy change at 298K ?

   (a) $-8780\ J\ mol^{-1}$ (b) $-532\ J\ mol^{-1}$ (c) $-3572\ J\ mol^{-1}$ (d) $-87\ kJ\ mol^{-1}$

7. At 298 K, the emf of the cell

   $$Hg \left| \begin{matrix} 0.01\ mol\ dm^{-3}\ KCl \\ sat.\ with\ Hg_2Cl_2 \end{matrix} \right\vdots \begin{matrix} 1\ mol\ dm^{-3}\ KNO_3 \\ salt.\ bridge \end{matrix} \left\vdots \begin{matrix} 1\ mol\ dm^{-3}\ KOH \\ salt.\ with\ HgO \end{matrix} \right| Hg$$

   is found to be 0.1634V and the temperature coefficient of the emf to be $0.000837\ VK^{-1}$. Calculate the entropy change of the reaction.

   (a) $162\ JK^{-1}\ mol^{-1}$ (b) $162\ KJ\ K^{-1}\ mol^{-1}$ (c) $16.6\ JK^{-1}\ mol^{-1}$ (d) $16.6\ KJ\ K^{-1}\ mol^{-1}$

QUANTA POINT

8. For the following cell

$Pb\,|\,PbCl_2(s)\,|\,PbCl_2(soln.) + AgCl(s)\,|\,Ag$

the potential at 298K is 0.490V and the variation of emf with temperature is given by

$E = a - (1.86 \times 10^{-4}\ VK^{-1})\ (T - 25K)$

Write the equation for the cell reaction and calculate ΔH for the reaction at 298K.

(a) -105.2 J mol^{-1} (b) -105.2 KJ mol^{-1} (c) -35.9 J mol^{-1} (d) -35.9 KJ mol^{-1}

9. At 273K, the calorimetric determination of ΔH for the reaction

$Zn(s) + 2AgCl(s) \rightarrow ZnCl_2(aq) + Ag(s)$

yielded -217.78 kJ mol^{-1}, while the emf of the corresponding cell was 1.015 V. What is $(\partial E/\partial T)_p$ of the cell?

(a) -4.1×10^{-4} (b) -4.1×10^{-3} (c) 4.1×10^{-4} (d) 4.1×10^{-3}

10. Determine the standard equilibrium constant of the following reaction at 298K

$$2MnO_4^- + 6H^+ + 5H_2C_2O_4 \rightarrow 2Mn^{2+} + 8H_2O + 10CO_2$$

(a) 10^{100} (b) 10^{200} (c) 10^{330} (d) 10^{150}

11. $\Delta G = \Delta H - T\Delta S$ and $\Delta G = \Delta H + T\left[\dfrac{d(\Delta G)}{dT}\right]_p$ then $\left(\dfrac{dE_{cell}}{dT}\right)$ is:

(a) $\dfrac{\Delta S}{nF}$ (b) $\dfrac{nE}{\Delta S}$ (c) $-nFE^{cell}$ (d) $+ nEF_{cell}$

12. ΔG is the available energy (energy produced) during the electrochemical reaction in galvanic cell which can be converted into useful work. In the light of second law of thermodynamics in the cell the change in electrode potential with temperature will be equal to

(a) $\dfrac{\Delta S}{nF}$ (b) $\dfrac{nF}{\Delta S}$ (c) $-2.303\ RT \log K_c$ (d) $\dfrac{-2.303RT}{nF}$

13. The solubility product of silver iodide is 8.3×10^{-17} and the standard reduction potential of Ag, Ag^+ electrode is + 0.8 volts at 25°C. The standard reduction potential of Ag,AgI/I^- electrode from these data is.

(a) – 0.15 V (b) –0.45 V (c) +0.35 V (d) +0.45 V

14. The standard emf of the cell, $Cd(s)\,|\,CdCl_2(aq)\ (0.1\ M)\,||\,AgCl(s)\,|\,Ag(s)$ in which the cell reaction is, $Cd(s) + 2AgCl(s) \longrightarrow 2Ag(s) + Cd^{2+}(aq) + 2Cl^-(aq)$ is 0.6915 V at 0°C and 0.6753 V at 25°C. The $\Delta H°$ of the reaction at 25°C is

(a) – 176 kJ (b) – 234.7 kJ (c) + 123.5 kJ (d) – 167.26 kJ

15. The temperature coefficient, of the emf i.e. $\dfrac{dE}{dT} = -0.00065$ volt. deg^{-1} for the cell $Cd\,|\,CdCl_2(1M)\,||\,AgCl(s)\,|$ Ag at 25°C. Calculate the entropy changes ΔS_{298K} for the cell reaction, $Cd + 2AgCl \rightarrow Cd^{++} + 2Cl^- + 2\,Ag$

(a) – 105.5 JK^{-1} (b) – 150.2 JK^{-1} (c) – 75.7 JK^{-1} (d) – 125.5 JK^{-1}

16. At 27°C $\left(\dfrac{\partial E°}{dT}\right)_p = -1.45 \times 10^{-3}\ VK^{-1}$ and $E°$=1.36V

For the cell $Pt\,|\,H_2(g)\,|\,HCl(aq)\,|\,Cl_2\,|\,Pt$.

Calculate entropy and enthalpy change in this standard state.

QUANTA POINT

(a) $-962.48\ JK^{-1}$, $-346.435\ KJ$ (b) $-279.85\ JK^{-1}$, $-346.453\ KJ$

(c) $-1326.23\ JK^{-1}$, $-346.435\ KJ$ (d) $-280.24\ KJK^{-1}$, $-346.435\ KJ$.

Multiple Select Questions (MSQs)

17. $Pt|H_2|H^+||Cu^{2+}|Cu$

For this cell,

(a) $E_{cell} \uparrow$ with $\uparrow$ in temp (b) $E_{cell} \downarrow$ with $\uparrow$ in temp

(c) No change in E with change in temp (d) Temperature coefficient is negative

18. $Pt|Zn|Zn^{2+}||Cl^-|Cl_2|Pt$

For this cell,

(a) $\frac{dE}{dT} = 0$ (b) $\frac{dE}{dT} = +ve$

(c) $\frac{dE}{dT} = -ve$ (d) Pressure of $Cl_2 \downarrow$ during the course of reaction

Numerical Answer Type (NAT)

19. A cell reaction, $Zn + 2Fe^{3+} \rightleftharpoons 2Fe^{2+} + Zn^{2+}$, works at 25°C with the cell emf 1.2 volt and at 45°C with the cell emf 1.718 volt. Assuming $\Delta S°$ to be constant in this temperature range, calculate $\Delta S°$ in kJ $mol^{-1}K^{-1}$. (Give your answer in the nearest integer).

20. At 298K the standard free energy for formation of $H_2O(l)$ is -237.23 kJ mol^{-1}, while that of its ionizationof hydrogen and hydroxyl ions is 79.71 kJ mol^{-1}. What will be the reversible emf at 298K of the cell. (nearest to two decimal place)

$Pt \mid H_2(g, 1\ bar) + H^+(1M) \vdots OH^-(1M) \mid O_2(g, 1\ bar) \mid Pt$

QUANTA POINT

DPP- (8) Electrochemistry

Multiple Choice Questions (MCQs)

1. $Pt \mid Ag \mid AgCl \mid Cl^-(a_1) \vdots Cl^-(a_2) \mid AgCl \mid Ag \mid Pt$

Which of the following statement is correct?

(a) $E_{WLJP} > E_{WOLJP}$ when $a_1 > a_2$ and $t_+ > t_-$ (b) $E_{WLJP} > E_{WOLJP}$ when $a_1 < a_2$ and $t_+ > t_-$

(c) $E_{WLJP} < E_{WOLJP}$ when $a_1 > a_2$ and $t_+ > t_-$ (d) $E_{WLJP} < E_{WOLJP}$ when $a_2 > a_1$ and $t_+ > t_-$

2. $Pt \mid H_2 \mid (HCl(a_1) \vdots HCl(a_2) \mid H_2 \mid Pt$. Select condition for spontaneous working of cell.

(a) $E_{WLJP} > E_{WOLJP}$ when $a_1 > a_2$; $t_- > t_+$ (b) $E_{WLJP} > E_{WOLJP}$ when $a_2 > a_1$; $t_- > t_+$

(c) $E_{WLJP} < E_{WOLJP}$ when $a_1 > a_2$; $t_- > t_-$ (d) $E_{WLJP} < E_{WOLJP}$ when $a_2 > a_1$; $t_- > t_+$

3. $Pt\left|H_2(g)\right|_{(1\ atm)}\left|H^+(0.1M)\right\|H^+(0.1M)\left|H_2(g)\right|_{(1\ atm)}Pt.$ Find E_{cell}

(a) 2.5V (b) 0V (c) 1.5V (d) 0.5V

4. $Pt \left| Cl_2 \right| \underset{(a_1)}{KCl} \vdots \underset{(a_2)}{KCl} \left| \underset{(g)}{Cl_2} \right| Pt$

Which of the following statement is correct

(a) t_+ KCl $(a_1) \rightarrow t_+$ KCl (a_2) (b) t_- KCl $(a_1) \rightarrow t_-$ KCl (a_2)

(c) t_+ KCl $(a_2) \rightarrow t_+$ KCl (a_1) (d) t_- KCl $(a_2) \rightarrow t_-$ KCl (a_1)

5. $Pt \mid Ag \mid AgCl\left|\underset{(0.1M)}{KCl}\right\|\underset{(0.2M)}{KCl}\left|\underset{(0.2atm)}{Cl_2}\right|Pt$

Find E_{cell}.

(a) 0.28 V (b) 0.059V (c) 0.32V (d) 0.118V

6. $Pt\left|\underset{(0.1\ atm)}{Cl_2}\right|\underset{(0.1M)}{KCl}\left\|\underset{(0.2M)}{KCl}\right|\underset{(0.2atm)}{Cl_2}\left|Pt\right.$. Find E_{cell}

(a) -8.89×10^{-2}V (b) -8.89×10^{-1}V (c) -8.89×10^{-3}V (d) 0 V

7. $Pt\left|\underset{(P_1)}{H_2(g)}\right|H^+(aq)\left|\underset{(P_2)}{H_2(g)}\right|Pt$

EMF is given by

(a) $\frac{RT}{F}\ln\frac{P_1}{P_2}$ (b) $\frac{RT}{2F}\ln\frac{P_1}{P_2}$ (c) $\frac{RT}{F}\ln\frac{P_2}{P_1}$ (d) $\frac{RT}{2F}\ln\frac{P_2}{P_1}$

8. $Pt\left|\underset{1atm}{Cl_2}\right|Cl^-(xM)\left\|Cl^-(0.1M)\right|\underset{1atm}{Cl_2}\left|Pt\right.$

QUANTA POINT

Find $\log_{10} x$ if $E_{cell} = 0.3456V$.

(a) 3.9 (b) 4.8 (c) 2.1 (d) 5.7

9. $Pt\,|\,Ag\,|\,AgCl\,|\,Cl^-(a_1) : Cl^-(a_2)\,|\,AgCl\,|\,Ag\,|\,Pt$

Which of the following statement is correct?

(a) E_{LJP} = +Ve when $a_1 > a_2$ and $t_+ > t_-$ (b) E_{LJP} = +Ve when $a_2 > a_1$ and $t_+ > t_-$

(c) E_{LJP} = +Ve when $a_1 > a_2$ and $t_- > t_+$ (d) E_{LJP} = +Ve when $a_2 = a_1$ and $t_+ > t_-$

10. $Pt\,|\,Ag(s)\,|\,AgCl(s)\,||\,KCl(a_1)\,\vdots\,KCl(a_2)\,|\,AgCl(s)\,|\,Ag(s)\,|\,Pt$

Which of the following statement is correct?

(a) t_- KCl $(a_2) \rightarrow t_-$KCl (a_1) (b) t_+ KCl $(a_1) \rightarrow t_+$KCl (a_2)

(c) t_+ KCl $(a_2) \rightarrow t_+$KCl (a_1) (d) t_- KCl $(a_1) \rightarrow t_+$KCl (a_2)

11. $Pt\,|\,H_2\,|\,HCl\,(a_{\pm})_1\,|\,AgCl(s)\,|\,Ag(s) - Ag(s)\,|\,AgCl(s)\,|\,HCl\,(a_{\pm})_2\,|\,H_2\,|\,Pt$

Which of the following statement is correct?

(a) $E_{cell} = \dfrac{RT}{F}\ln\dfrac{(a_{\pm})_2}{(a_{\pm})_1}$ (b) $E^{\circ}_{cell} = 0$

(c) $E^{\circ}_{cell} = \dfrac{2RT}{F}\ln\dfrac{(a_{\pm})_2}{(a_{\pm})_1}$ (d) $E_{cell} = -\dfrac{2RT}{F}\ln\dfrac{(a_{\pm})_2}{(a_{\pm})_1}$

12. $Pt\left|Zn - Hg(C_1)\right|\left|ZnCl_2\right|_{0.2M}\left|Zn - Hg(C_2)\right|Pt$

For a working cell

(a) $C_1 > C_2$ (b) $C_1 < C_2$ (c) $C_1 = C_2$ (d) Can't predict

13. $Pt\left|H_2\right|_{(0.1bar)}\left|HCl\right|\left|H_2\right|_{(0.01bar)}\left|Pt\right.$

Find E_{cell}.

(a) 0.295 V (b) 0.0295V (c) 2.95V (d) –0.0295V

14. Calculate the emf of amalgam concentration cell at 333K:

$Zn(Hg)(c_1)\,|\,ZnSO_4(aq.)\,|\,Zn(Hg)(c_2)$

when c_1 and c_2 are 6.08×10^{-5} and 2.28×10^{-3} mol dm^{-3} respectively. The amalgams may be consider ideal.

(a) 0.09V (b) 0.01V (c) 0.06V (d) 0.9V

15. If activities equal concentrations, what is the potential at 298K of

$Pt\,|\,Na(0.2\%\text{ in Hg})\,|\,NaCl(0.15\text{ mol kg}^{-1})\,|\,AgCl(s)\,|\,Ag\,|\,AgCl(s)\,|\,NaCl\,(0.0372\text{ mol kg}^{-1})\,|\,Na\,(0.2\%\text{ in Hg})\,|\,Pt$

(a) –0.07V (b) –0.051V (c) 0.072V (d) –0.51V

Multiple Select Questions (MSQs)

16. $Pt\left|H_2\right|_{(1\text{ bar})}\left|HCl(a_1)\right|HCl(a_2)\left|Cl_2\right|_{(1bar)}\left|Pt\right.$

For a working cell

QUANTA POINT

(a) $a_1 > a_2$ (b) $a_2 > a_1$ (c) $\frac{a_1}{a_2} > 1$ (d) $\frac{a_2}{a_1} > 1$

17. $Pt\left|\underset{(1\ bar)}{Cl_2}\right|HCl(a_1)\left|HCl(a_2)\right|\underset{(1bar)}{Cl_2}\left|Pt\right.$. Choose correct option for working cell

(a) $a_1 > a_2$ (b) $a_1 < a_2$ (c) $\frac{a_1}{a_2} > 1$ (d) $\frac{a_2}{a_1} > 1$

18. $Pt \mid H_2(P_1) \mid HCl(a_1) \vdots HCl(a_2) \mid H_2(P_2) \mid Pt$

for a working cell

(a) $a_1 (P_2)^{1/2} < a_2(P_1)^{1/2}$ (b) $a_1 (P_2)^{1/2} > a_2(P_1)^{1/2}$

(c) $\frac{a_1}{a_2} > \left(\frac{P_1}{P_2}\right)^{1/2}$ (d) $\frac{a_1}{a_2} < \left(\frac{P_1}{P_2}\right)^{1/2}$

Numerical Answer Type (NAT)

19. Find the cell reaction and calculate the potential of the following cell at 298K
$Cd(s) \mid CdSO_4(0.01\ mol\ kg^{-1}, \gamma = 0.383) \mid PbSO_4(s) \mid Pb - Pb \mid PbSO_4(s) \mid CdSO_4\ (1.00\ mol\ kg^{-1}, \gamma = 0.042) \mid Cd(s)$

20. Calculate the potential (in volts) at 298K of the following cell.
$Zn\ (s) \mid ZnCl_2(m = 0.01\ mol\ kg^{-1}, \gamma_{\pm} = 0.708) \mid AgCl(s) \mid Ag - Ag \mid AgCl\ (s) \mid ZnCl_2(m = 0.10\ mol\ kg^{-1}, \gamma_{\pm} = 0.502) \mid Zn(s)$

QUANTA POINT

Electrochemistry

ANSWER KEY

DPP-1

1.	(b)	2.	(c)	3.	(b)	4.	(d)	5.	(a)	6.	(b)	7.	(a)
8.	(d)	9.	(b)	10.	(b)	11.	(a)	12.	(a)	13.	(b)	14.	(d)
15.	(c)	16.	(a,b,c)	17.	(a,b,d)	18.	(a,b,c)	19.	(1.159 V)			20.	(0.21)

DPP-2

1.	(d)	2.	(b)	3.	(c)	4.	(a)	5.	(b)	6.	(d)	7.	(a)
8.	(c)	9.	(a)	10.	(c)	11.	(d)	12.	(a)	13.	(c)	14.	(a)
15.	(a)	16.	(a,d)	17.	(a,b,c,d)			18.	(a,b,c)			19.	(2)

DPP- 3

1.	(a)	2.	(a)	3.	(c)	4.	(a)	5.	(b)	6.	(c)	7.	(b)
8.	(d)	9.	(c)	10.	(c)	11.	(a)	12.	(c)	13.	(c)	14.	(b)
15.	(d)	16.	(a,b,d)	17.	(a,c,d)	18.	(a,c)	19.	(0.035 V to 0.040 V)				
20.	(4)												

DPP-4

1.	(c)	2.	(d)	3.	(b)	4.	(b)	5.	(a)	6.	(c)	7.	(c)
8.	(a)	9.	(b)	10.	(c)	11.	(c)	12.	(b)	13.	(c)	14.	(a)
15.	(b)	16.	(a,b,c)	17.	(a,c)	18.	(a,c,d)	19.	(0.70 to 0.71)				
20.	(0.21 V to 0.22 V)												

DPP-5

1.	(a)	2.	(d)	3.	(c)	4.	(a)	5.	(c)	6.	(a)	7.	(c)
8.	(d)	9.	(a)	10.	(d)	11.	(b)	12.	(c)	13.	(d)	14.	(a)
15.	(c)	16.	(c)	17.	(a,d)	18.	(a,c)	19.	(338)	20.	(10)		

DPP-6

1.	(d)	2.	(a)	3.	(a)	4.	(b)	5.	(c)	6.	(b)	7.	(b)
8.	(a)	9.	(b)	10.	(b)	11.	(b)	12.	(a)	13.	(b)	14.	(d)
15.	(b)	16.	(b,d)	17.	(b,c)	18.	(a,c)	19.	(58.4)	20.	(6.09)		

QUANTA POINT

DPP-7

1.	(b)	2.	(a)	3.	(a)	4.	(b)	5.	(a)	6.	(a)	7.	(a)
8.	(b)	9.	(a)	10.	(c)	11.	(a)	12.	(a)	13.	(d)	14.	(d)
15.	(d)	16.	(b)	17.	(b,d)	18.	(c,d)	19.	($5\ kJ\ mol^{-1}K^{-1}$)				
20.	(0.40V)												

DPP-8

1.	(a)	2.	(b)	3.	(b)	4.	(a)	5.	(d)	6.	(c)	7.	(b)
8.	(b)	9.	(a)	10.	(b)	11.	(c)	12.	(a)	13.	(b)	14.	(a)
15.	(a)	16.	(b,d)	17.	(a,c)	18.	(a,d)	19.	(0.0615V)			20.	(0.0755V)